DEVELOPMENT AND AUTOMATION OF PHOTOBIOREACTORS FOR MICROALGAE INTENSIVE CULTURES FOR THE USE IN INDUSTRIAL GAS STUDIES

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"Abstract-" Although photobioreactors provide much more advantages over open cultivation systems, still more work has to be done in making them cost effective to set up and to operate than conventional pipe reactors and which give high algae yields. This study develops the design of two automation tubular photobioreactors of 550 L for intensive microalgae cultures.

"Keywords-" Automation of photobioreactors, microalgae intensive cultures, industrial gases.

The design of these, comprise two principal parts:
- An illuminated tubular part (Figure 1) connected to a degassing reactor by variable flow peristaltic pumps (up to 8000 L h-1). This recirculation flow can be controlled and regulated by Electromagnetic Flow Meters. The illumination is followed by two panels with 126 specific LED focus for each of the two photobioreactors. Each one of these LED bulbs has a power of 12 W and consists of 138 red LEDs (650 nm) and 30 blue LEDs (420 nm). This provides useful photosynthetic light which does not generate heat and has a reduced energetic consumption. The illumination of these LEDs is externally controlled by radiance sensors and the intensity can be regulated.
- And the degassing reactors (Figure 2) which have a volume of 250 L and are aerated with gas compressors regulated by mass flow meters.

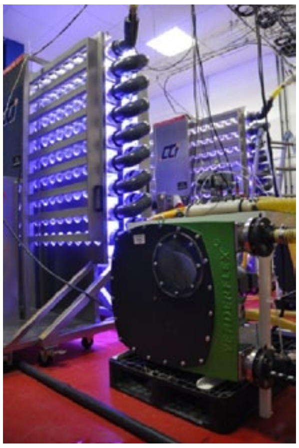

Fig. 1. Illuminated tubular part of the photobioreactor

Fig. 2. The degassing reactor.

Each of the photobioreactors are continuously monitored by two sensors of pH, oxygen and temperature (these are situated in the inlet and output of the illuminated part), and two turbidity sensors (which can be used as indicative of biomass). The idea would be to follow a fed-batch culture; therefore there is a continuous sample extraction which is replaced by the addition of nutrients and seawater by the use of peristaltic pumps. Also, the laboratory is thermotatized and includes a system to filtrate and sterilize seawater (UV).
Once the samples are extracted they are filtered in line and the concentration of nutrients is determinated in an automatic way by a nutrients analyzer, also in line. The injection of CO2 and other possible gases, aim of the study, are injected by regulated mass flow meters. Gas concentrations of CO2 and the other possible gases are analyzed, including the reference of gas added from by the gas compressors (inlet) and from the exit of the degassing reactor (outlet) to be able to establish balances (Figure 3).
All the system is controlled by a Siemens PLC, shown in Figure 4, which relate control values such as pH for example to injection of CO2 and measured nutrients in samples to addition of these.

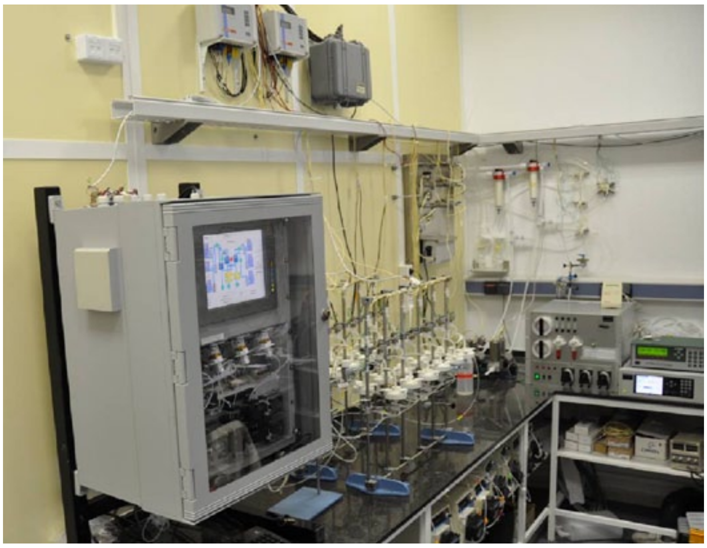

Fig. 3. On-line system of filtration of samples and analysis of nutrients and gases.

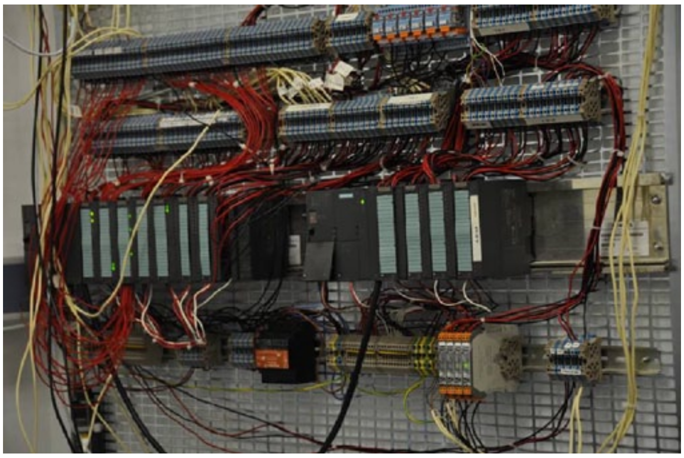

Fig. 4. Siemens PLC system for the automation of the photobioreactors

At this moment the two photobioreactors are operating with Nannochloropsis gaditana and Tetraselmis chuii and are resulting to be very effective and easy to control. The use of these photobioreactors allows a large amount of possible studies by the use of different microalgae strains and possible injection of industrial gases.

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